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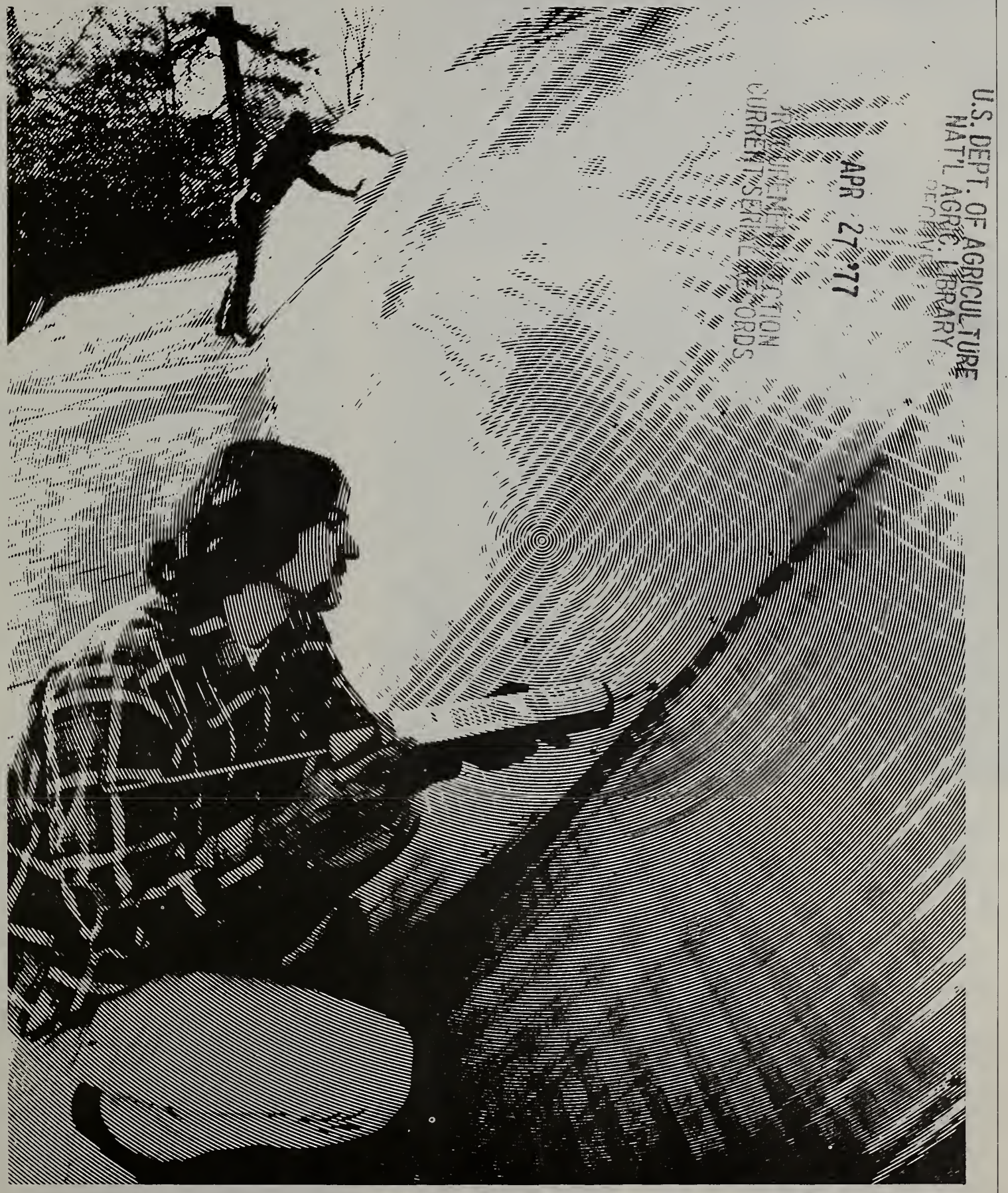
U.S. DEPARTMENT OF AGRICULTURE APRIL 1977



agricultural research

April 1977/Vol. 24, No. 10

A Promise of Things to Come

After the roaring, chilling cold of winter, the soothing breath of Spring is very welcome. The Winter of '77 was truly a beast—harsh, cruel, and unrelenting in much of the Nation.

Now, perhaps, Spring can placate the savage Winter, or at least help erase the memory.

Spring is gentle. She brings fragile-looking crocuses, brilliant tulips and daffodils, and fruit trees bursting into bloom.

This pleasant interlude is a time to enjoy and plan for the coming Summer.

One of the more hopeful things we can do this Spring is to plant a tree. It is still too soon to fully assess the damage caused by the Winter of '77, but surely many trees perished.

Of all of Nature's masterpieces, trees are perhaps the loveliest. Regardless of variations in genus and species, all feature graceful branches that bend and sway in Spring's gentle breezes.

A variety of tree sizes and shapes makes the landscape interesting, sometimes even breathtaking. Even in today's harried world, we spend many idyllic moments relaxing under a tree.

Planting a tree on Arbor Day demonstrates an awareness of conservation, and a dedication to the meaning of life. All 50 States now observe Arbor Day—usually during April.

Merely planting a tree isn't enough, however. For the tree to flourish, it must overcome many obstacles that humans, sometimes unwittingly, have placed before its growth.

Along with a never-ending battle against insects and disease, today's trees must cope with air pollution, road salt, and many other dangers of modern civilization.

ARS scientists are selecting and breeding new trees to withstand these new perils, as well as the traditional foes. Results of this research are not easy to measure. Today's research may not pay off for another 30 or 40 years. Even the mighty oak takes 60 to 80 years to mature.

Spring may be fleeting, but a tree is not. A young tree planted on Arbor Day, like today's agricultural research, is but a promise of things to come.—*M.M.M.*

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COVER: Pale wintry sun illuminates the translucent fiberglass panels of an experimental solar home. Michael Granger, copartner of Helio-Thermics, Inc., builders of the house, completes caulking of the panels which have a total surface of 365 square feet (1275X2336–19). Article begins on page 10.

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The U.S. Cotton Ginning Research Laboratory at Stoneville, Miss., has installed a small, multichamber incinerator to study its ability to convert cotton gin waste into useable onsite energy. Mr. McCaskill regulates combustion air to the incinerator which operates on a controlled or "starved air" principle. Precise air control is necessary to drive gasses from the lower chamber into the second chamber where they burn like natural gas (1176X1495–18).

Energy from Cotton Gin Waste

REPLACE high-priced fossil fuels with incinerated cotton gin waste? This engineering dream is becoming a reality as waste products from cotton are transformed into usable onsite energy.

Research on a heat-recovery system developed at the U.S. Cotton Ginning Research Laboratory (Box 256, Stoneville, MS 38776), indicates that 31.4 percent of the heat from combustion of gin trash can be recovered and efficiently delivered to the seed-cotton drying system.

ARS engineers Oliver L. McCaskill and Richard A. Wesley report that an annual cotton crop of 12 million bales creates over 2 million tons of cotton ginning waste material. This tonnage is based on 79 percent of the crop being machine picked, with an average of 200 pounds of trash per bale, and 21

Left: *Gin trash is fed into a suction line to the incinerator by electrician's aide Willie Smith. Under normal conditions, trash is fed directly from the gin, concurrent with ginning. For test purposes, however, the trash is weighed and analyzed for moisture content before being fed into the incinerator in specific quantities, enabling researchers to arrive at accurate heat recovery ratios (1176X1494–16).* ***Above:*** *The U.S. Cotton Ginning Laboratory in operation. The research gin is equipped with full-scale commercial machinery (1176X1492–7).*

percent of the crop being machine stripped, with an average of 840 pounds of trash per bale.

The heat value of cotton gin wastes averages 7,928 British thermal units (Btu's) per pound dry weight or about 7,000 Btu's per pound at 11 percent moisture content. "The total potential heat recovery from 2 million tons of waste would be 28 trillion Btu's," says Mr. McCaskill. "If we can recover only 30 percent of this potential, it would amount to 8 trillion Btu's—more than enough heat to dry the entire 12-million-bale annual crop."

The laboratory has installed a small, multichamber incinerator to study its ability to dispose of cotton gin waste. It is rated at 470 pounds per hour of type "O" waste by the manufacturer and equipped with a bulk trash storage and feeder, an automatic ash removal system, and an air-to-air heat exchanger in the stack. Type "O" waste is a mixture of highly combustible waste with a 10-percent moisture content, an 8,500-Btu value per pound, a density of 8 to 10 pounds per cubic foot, and an ash residue of 5 percent.

The incinerator operates on the controlled-air principle. Waste is heated in the lower chamber by control of air introduction which, in turn, controls the temperature. Only smoke, unburned gases, and very small particles pass into the upper chamber. In the upper chamber the smoke is ignited and additional air is introduced so that the gases and smoke particles are oxidized rapidly. The high-temperature gases leave the upper chamber and enter the heat exchanger where they are cooled by ambient air that passes through the heat exchanger.

The automatic batch waste loader and the air-to-air heat exchanger purchased with the incinerator proved unsatisfactory for incinerating gin waste and ginning at the same time.

Modification of the original system was begun in 1975 to improve the burning capacity, increase heat-recovery efficiency, and reduce the initial cost. First, the bulk trash storage and the automatic batch loader were replaced with a simple, continuous-feed system. It consists of a high-efficiency cyclone, equipped with a vacuum feeder that discharges into a screw conveyor. The screw conveyor is overhung for elimination of the end bearing at the incinerator.

A plug of gin waste is formed at the end of the screw conveyor before it enters the incinerator chamber. Ambient air jets are directed toward the end of the screw in the conveyor so it will be protected from the high temperatures in the incinerator during burning.

This inexpensive feed system is performing well, say the scientists. However, overloading could be a problem and it will be necessary for the incinerator to be sized for the maximum anticipated loading of waste from the gin. The feed system had no effect on the burning capacity of the incinerator.

The original heat exchanger was inefficient and was replaced with one designed and constructed at the Stoneville laboratory. Also changed was the fan arrangement to eliminate heat loss caused by air leakage. A 21-inch vane-axial fan driven by a 15-horsepower motor was installed on the inlet to the heat exchanger to insure positive pressure of the ambient air and to over-

come the static pressure loss across the heat exchanger.

The hot-air fan was moved back inside the gin building just ahead of the feed control, and the modulating valve was installed at the exit from the heat exchanger.

The conventional natural gas burner remained in its position in series with the heat exchanger. The gas burner then could assist with initial startup and supplement the heat exchanger if it became necessary. Both the modulating valve and the gas burner were regulated by the same controller.

The heat exchanger was the primary heat source and the gas burner was the secondary source.

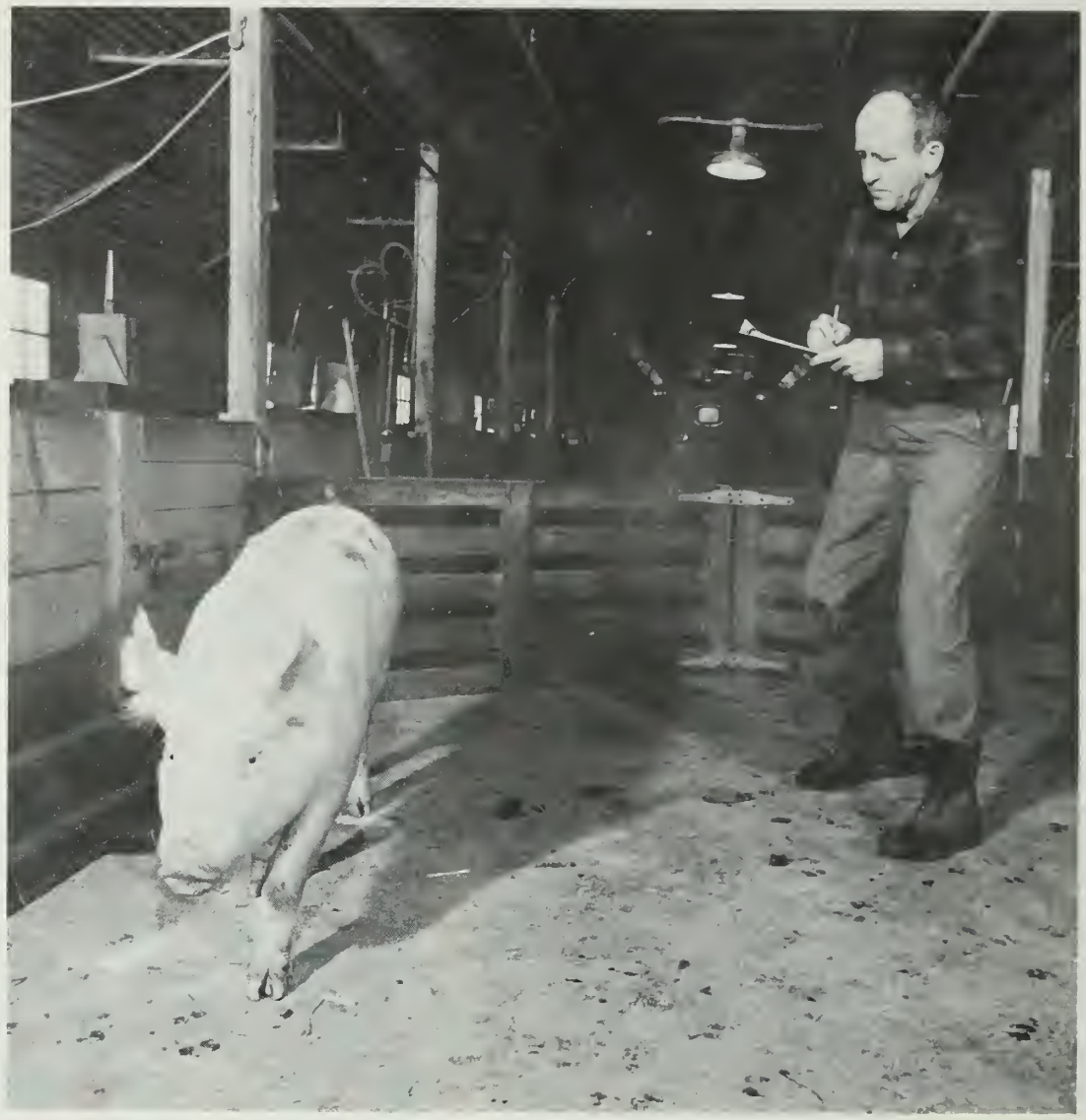
The maximum capacity of this size and type of incinerator was 350 to 400 pounds of trash per hour, depending on the amount of lint-cleaner waste.

Having accomplished their original goal of 30 percent overall recovery of heat, the scientists are now sampling to determine the level of particulate emission. They estimate the opacity, indicating the amount of particles in the discharged smoke, at less than 10 percent.

Several commercial incinerator companies are currently testing and using the new method of converting gin waste to energy.

In 5 years, say Mr. McCaskill and Mr. Wesley, a ginner could amortize an incinerator investment cost of almost $80,000. When the potential value of cotton gin trash as a source of fuel is compared with the cost of natural gas—currently priced about $2 or more per 1,000 cubic feet—the value of the trash rises impressively.—*P.L.G.*

Above: A single panel controls the operations of the research gin. Here, gin manager Frank M. Giardina selects cotton-drying temperatures (1176X1493–21A). ***Upper right:*** *With skill developed through years of ginning experience, Mr. McCaskill estimates by feel the moisture content of seed cotton, which has been dried by heat recovered from incinerated gin trash (1176X1493–35A).* ***Lower left:*** *Mr. Wesley checks the printout tape of the ginning laboratory's data collection station. The temperatures are monitored throughout the heat-recovery system, from the primary chamber in the incinerator to the cotton dryer in the gin (1176X1493–9A).* ***Lower right:*** *A 500-pound bale of cotton is removed from the gin press by its operator, Johnny O. Strickland. The gin used in this research project has a production capacity of 10 to 12 bales of cotton per hour (1176X1494–34).*



Dr. Bereskin evaluates feet and leg movement and structure of a 5-month-old Yorkshire boar (0177X080–33).

Toward Stronger Legs and Feet

MODERN METHODS of raising pigs may be cleaner and more efficient, but they have taken their toll by producing pigs with weak feet and legs. When pigs were raised on pasture, the soft ground provided a cushion for their feet. Modern methods of raising pigs on concrete have contributed to stiff legs and weak feet in our modern breeds of swine.

Nationally, about 10 percent of the boars destined for sale by central testing stations are eliminated from public auction because of unsound feet and legs. In two recent national production tests by breed registries, over 30 percent of the boars tested were eliminated due to unsound feet and legs.

Until recently, little was known about the heritability, genetic correlations, or opportunities for improving feet and legs in our herds. However, geneticist Ben Bereskin, Beltsville Agricultural Research Center (Room 216, Building 200, BARC–E, Beltsville, MD 20705), has found that unsound feet and legs are moderately heritable, so that in most herds this condition could be largely eliminated in two to four generations of careful selection.

For his research, Dr. Bereskin selected foundation animals from several of the leading Duroc and Yorkshire herds in the country. Litters were far-

rowed in a central farrowing barn and put on pasture at about 2 weeks of age. After weaning at 6 weeks of age, pigs were put in concrete-floored pens with a limited amount of straw bedding and fed free-choice a 16-percent protein diet. Pigs were removed from test at 200 pounds, scanned ultrasonically, and scored for soundness in their feet and legs. Structure and movement of both front and rear feet and legs were scored by Dr. Bereskin and swine herdsman Robert Figulski.

In addition, data were taken on performance traits such as weight on test, average daily gain, average backfat thickness, and loin eye area. These traits were then compared with the scores for feet and legs to correlate performance traits with feet and leg soundness. Records were kept for 155 pigs from 47 litters sired by 25 different boars.

Weight on test was positively correlated with feet and leg scores. Thus, pigs with the fastest early growth generally were sounder in their feet and legs at 200 pounds. Average daily gain during the test period showed almost no correlation with feet and leg soundness, indicating that these are essentially genetically independent traits.

An important finding involved the correlations of feet and leg soundness with backfat thickness and loin eye area. Pigs with less backfat and larger loin eye areas generally were sounder in their feet and legs and moved more freely. These results indicate that selecting leaner and meatier pigs need not interfere with simultaneous selection for sounder feet and legs.

Dr. Bereskin recommends that breeders carefully examine their animals and select pigs with the proper set to their shoulders, hocks, and pasterns and with adequate spring and cushion in their feet and legs.

"Our test results indicate that careful selection and breeding practices could, within a reasonable time, produce faster gaining and leaner pigs with sound feet and legs, even on concrete," says Dr. Bereskin.—*M.E.N.*

Keeping Life Support Systems Going

CHEMICALS that can prolong life may result from the synthesis and study of nucleic acid analogs.

Continuing the process of cell division is the key to prolonging life. Chemist Joseph Corse, Western Regional Research Center (800 Buchanan St., Berkeley, CA 94710), says the changes that prevent cell division are not necessarily due to aging. He says these changes can result from the turning off of cell-dividing capacity.

A Polish project for which Dr. Corse is the cooperating scientist has provided information about deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) analogs that contain chemicals which can delay plant deterioration. "Our objectives," Dr. Corse says, "are to keep preprocessed plants and plant parts alive longer. ARS scientists are using natural compounds comparable to the analogs the Polish scientists developed to accomplish this by using the chemical mechanisms a plant might use for just such a purpose."

The living cells of higher plants and animals have three obvious stages at which functional control can be exerted.

Transcription, the first stage, is the process whereby the genetic instructions of DNA are copied onto a strand of messenger RNA (mRNA). At this stage, by switching genes on or off, the decision is made, "yes or no," whether to synthesize the specific enzyme that may initiate or accelerate a certain chemical reaction in the metabolism of plants and animals.

Stage two, translation, takes place in the cytoplasm of the cell where ribosomal RNA determines how much of the particular enzyme is to be made.

The third stage is concerned with how efficiently the enzyme works with its substrate. Substrates are molecules acted upon by enzymes to produce physiological changes.

The three stages have been compared to a radio. Transcription is the on-off switch. Translation is the volume knob, and enzyme activity, the fine-tuning knob.

Dr. Corse and his colleagues, who are conducting antisenescence studies of fruits and vegetables, are carrying out physiological assays of compounds that affect the translation stage in plant cells. Their aim is to improve flavor, color, and texture of these foods and, as a result, reduce waste and minimize the need for expensive, long-term refrigeration.

"In each species of plant or animal," Dr. Corse says, "there is a genetic message that predetermines the time of death. Whatever the suicide code is, the results of antisenescence studies will ultimately pass from the laboratories of the physiologist and the chemist to the breeder who will be able to take their findings and genetically change the code, delay the message."

Conducted under Public Law 480, the Polish project was directed by Dr. David Shugar at the Institute of Biochemistry and Biophysics, Warsaw, Poland.—*M.C.G.*

In the Tarkio River system small channels were dredged about 1920 to facilitate drainage of surface runoff. These channels eroded rapidly and are now 4 times wider and deeper than the original channels (PN–1422).

Erosion Problem Continues

GROWTH OF GULLIES and streams in a highly productive agricultural region is challenging researchers to gain new understanding of erosion and what can be done to minimize it.

Erosion has beset the Tarkio and other watersheds of southwestern Iowa and northwestern Missouri since about 1850 when pioneers settled the region, and the problem is far from being abated, says ARS hydraulic engineer Robert F. Piest (207 Business Loop 70 East, Columbia, MO 65201). Streams that were 20 to 30 feet wide in pioneer days are 150 feet wide today. Widths and depths of the tributaries to the Missouri River in the Tarkio area have increased fourfold in the past half century.

Mr. Piest expresses concern that progressive upstream deepening of channels often influences growth of gullies on farmland as much as water flowing through the gullies. Mr. Piest analyzed the patterns of gully and channel erosion along with planning engineer Loren S. Elliott of USDA's Soil Conservation Service (SCS), Des Doines, and ARS agricultural engineer Ralph G. Spomer, Council Bluffs, Iowa.

In their studies, the researchers used historic information from SCS surveys, U.S. Geological Survey records, drainage district records, and State and county highway surveys for bridges. The researchers related erosion patterns to intensity of agriculture, drainage gradients, changes in water content of soil along channel boundaries, and geologic characteristics of the region.

The rolling topography of the region was formed by glacial movement and subsequent wind deposition of a mantle of fine-particle soil called loess, up to 80 feet thick. The scientists found that the underlying channel materials vary in erodibility, but there is no base level to which channels can degrade and stabilize. As the channels deepen, nearly vertical loess sidewalls weaken, slough off into the streams, and are washed away.

"About one-fifth of the sediment that's moved through our streams in the loess region originates from gullies and channels," says Mr. Piest. The erosion problem is especially severe in May and June when frequent thunderstorms cause increased runoff of surface water over many rowcrop fields that have little or no vegetation. "Fields are cut up, soil nutrients are washed from fields, and agricultural chemicals that are bound to soil particles go downstream just where we don't want them," says Mr. Piest.

Scientists at Council Bluffs and other ARS locations are gathering data on the erosion process to develop mathematical expressions for assessing the environmental impact of soil and chemical movement at any site. A scientific understanding of the erosion process will help find the most efficient ways to minimize the impact, says Mr. Piest.

Returning the rich loess region, 65 percent of which is in field crops, to the idyllic pastoral systems of presettlement days might seem to be one way to minimize the erosion. But Mr. Piest sees no possibility for this happening while the world's need remains high for all-out production of food from crops. Conservation practices of today, such as terraces, minimum tillage, and stream gradient control structures, at least help in dealing with the erosion problem.

The Iowa Agriculture and Home Economics Station, Ames, cooperated in the study.—*G.B.H.*

Justice will be Served

For the first time in over 100 years, potato scab gnats can buzz about the planet exonerated from the accusation that they cause deep-pitted scab wounds on potatoes.

The potato scab gnat, *Pnyxia scabiei,* was first implicated as the cause of potato scab wounds in 1867, when it was reported that pin punctures in tubers became enlarged if the tubers were kept in a rearing jar containing scab gnats. It was thought that the gnat caused the wounds by feeding on healthy living tissue.

As a result of this report, the scab gnat was presumed guilty over the years, even though there were no adequate controls in the initial study. Doubt, however, did set in when chemical insecticides applied to potatoes failed to reduce the incidence of deep-pitted scab.

Suspicious that an injustice had been done, ARS researchers, led by entomologist George Tamaki (3706 West Nob Hill Boulevard, Yakima, WA 98901), conducted biological and ecological studies of the persecuted scab gnat.

Results of the study righted a long-standing wrong. The ARS researchers duplicated the original tests, this time using controls. Tubers were pricked on the face with a pin to form a barely visible "S," and then were placed face down in soil that was either infested with scab gnat larvae or free of scab gnats.

Within 3 to 4 days the letters on the tubers in the infested soil were becoming quite visible, indicating that the wound area was becoming enlarged. By the third day, scab gnat larvae were found in the wounds, just as in the original test, implying that indeed it was the scab gnat larvae that were enlarging the wounds.

However, the researchers found that the wound areas on tubers placed in gnat-free soil also enlarged. In fact, after 54 days of testing there were still no discernible differences between the width and depth of either set of tuber wounds.

Other ARS tests show that scab gnats feed primarily on fungus and do not cause deep-pitted scab.

Now that the innocent has been cleared, researchers can seek out the the true culprit and perhaps a long-standing problem to potato growers can be resolved.—*L.C.Y.*

New Process for Quick-cooking Rice

Rice consumption in the United States has increased over the past 15 years from about 5 pounds per person to about 8 pounds. This increase is generally attributed to the development and successful marketing of precooked or quick-cooking rice.

Researchers at the Western Regional Research Center (800 Buchanan St., Berkeley, CA 94710), have developed a new process for making quick-cooking rice. The process uses a new drier called a centrifugal fluidized bed (CFB) and reduces plant effluent and water and energy use. By merely changing precooking conditions, rice can be made "instant" or for use in casseroles or stuffing mixes.

"Our CFB quick-cooking rice has improved flavor because the process requires less time and doesn't heat the rice to the high temperatures of other methods," says food technologist Robert L. Roberts. "Our process works well with many rice varieties—short-, medium-, and long-grain types as well as wild rice."

The CFB drier is a rotating chamber that restrains the precooked rice kernels against a cylindrical screen with a force of 10 to 15 times gravity while high-velocity hot air is passed across the screen. Drying time is about 5 minutes—less than half that used for most patented quick-cooking rice processes.

In the precooking stage, raw white rice is soaked in cold water for about an hour to raise the moisture content from 12 to 30–33 percent. Then it is boiled 5 to 7½ minutes (depending on the type of end product desired) and quenched in cold water. The cooked rice has a moisture content of 60 to 65 percent.

In the drying step, air at about 295° F is forced at 3,000 feet per minute through the spinning bed of rice. This airflow is about 10 times the velocity generally used in most commercial dehydration equipment. This rapid drying removes moisture from the surface of each kernel as quickly as it diffuses from the interior. Final moisture content is 7 to 10 percent. A light, porous structure required for quick-cooking products is obtained in each kernel.

The CFB concept was originally developed by the Center's engineers for drying diced vegetables, such as carrots, potatos, or bell peppers. The batch-type pilot plant drier, used for quick-cooking rice development, could be modified for continuous flow to produce about 200 pounds per hour, say chemical engineers Robert A. Carlson and Daniel F. Farkas. They believe a drier with 1,000 pounds per hour production capacity could be designed.—*D.H.S.*

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Workman puts finishing touches on heat collectors of the ARS-designed solar home (1275X2336–36A).

Efficient, Economical

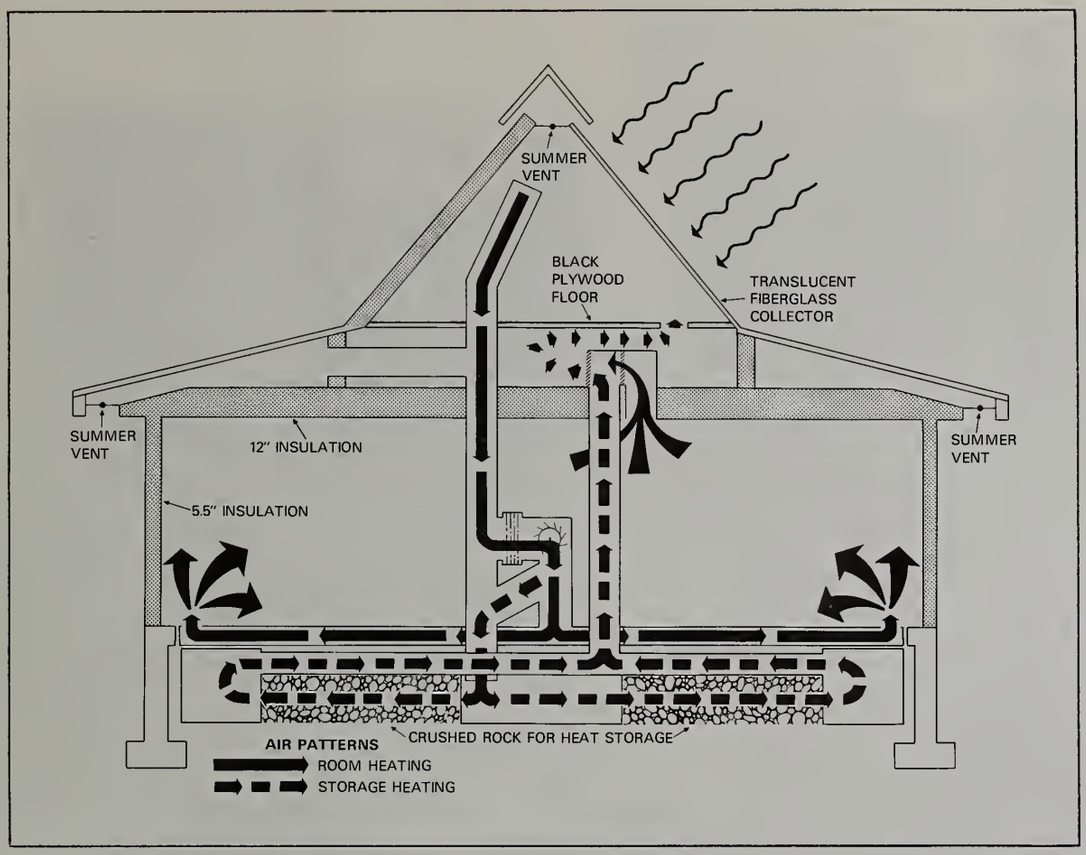
A small, solar-attie house was eonstrueted by ARS near Clemson, S.C., to test the efficieney of the prototype design. Here, agrieultural engineer Theodore Bond, leader of the Rural Housing Researeh Unit, and Mr. Godbey examine a printout from instrumentation loeated in the test unit (1275X2335–22)

A MEDIUM-PRICED, 3-bedroom family dwelling heated with solar energy has been constructed, and limited tests indicate it is a more efficient user of solar heat than expected.

The completely insulated attic of the house conserves energy and serves as the solar collector. Limited tests proved that the attic collects 59 percent of the solar energy available during clear days in January. Most solar collectors are considered efficient if they collect as much as 50 percent of the available energy.

In addition to the heat-collecting attic, a 12-inch layer of crushed rock beneath the house serves as a heat storage tank. The house is conventional in other respects.

The solar heating system is simple in design. Two layers of translucent fiberglass replace conventional roofing on the south roof slope and transmit sunshine or solar energy into the attic



Two operational modes are shown, indicating how solar heat is moved from the collector and either distributed directly into the house or diverted to rock storage. For simplicity, air diversion dampers are not shown (PN–4128).

and Affordable

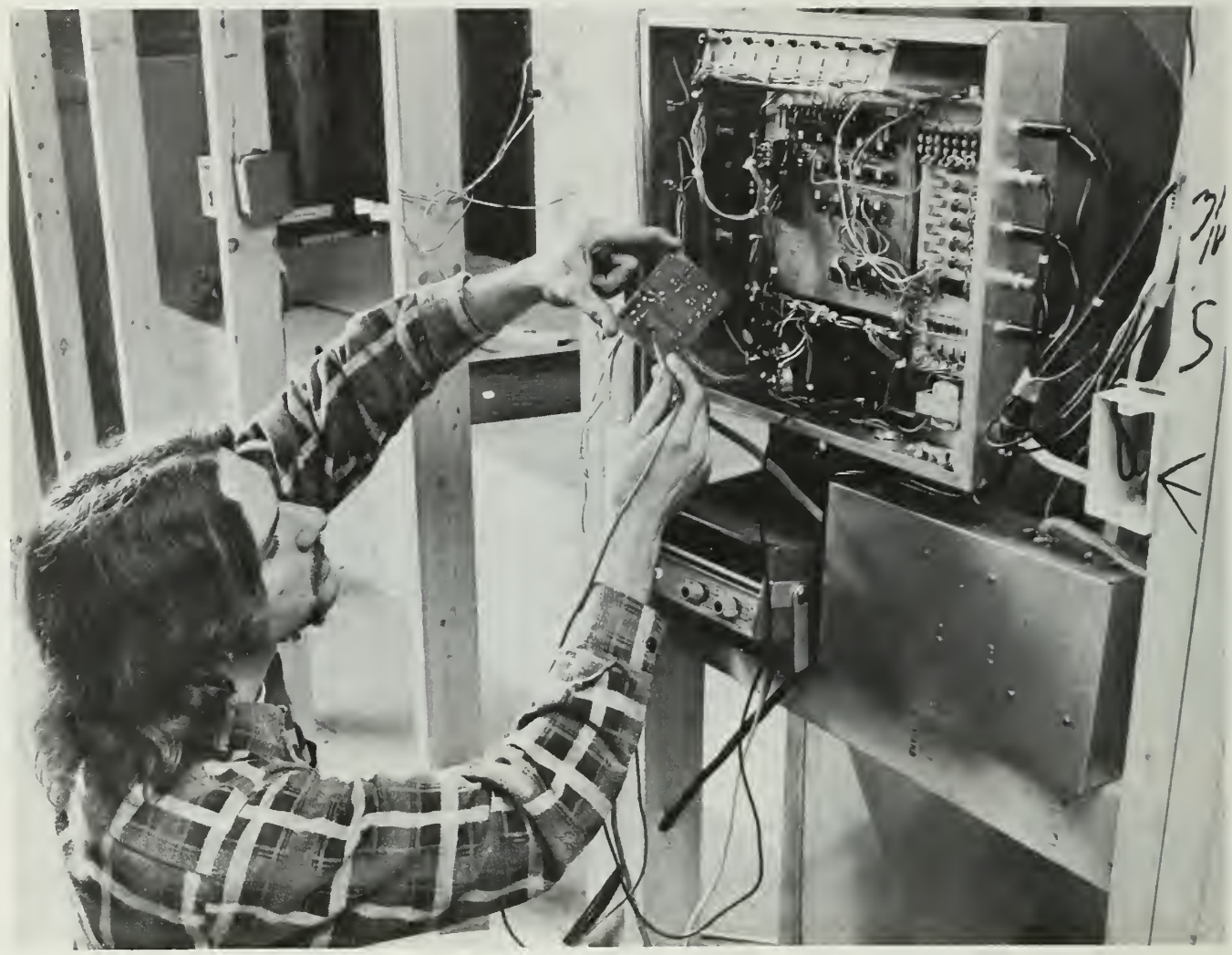
where it is absorbed by a black plywood oor. This heats the air in the attic and ne air is then circulated to heat the ouse and the rocks beneath the house. The rocks can store a 3-day supply of eat to warm the house at night and uring cloudy or rainy weather.

The solar-heated house was designed t the ARS Rural Housing Research Unit (P.O. Box 792, Clemson, SC 9631), by architect Harold F. Zornig. t is part of the ARS effort to lower the perating costs of rural housing with a ow-cost, low-maintenance heating sys- em using solar radiation as the energy ource. Such a heating system could be nodified to meet the demands of other eographic and climatic areas.

The estimated cost of heating the olar attic house in Greenville is about .7 cents per kilowatt-hour. This in- ludes the average heat load, the $2,635 nitial cost, 20-year amortization at 8½ ercent, and a 2-percent operation,

Researchers at the Rural Housing Unit are experimenting with various other types of solar collectors to better utilize the sun's rays. Shown with their designs are agricultural engineer Jerry O. Newman and Mr. Godbey (1275X2341–12).

Efficient, Economical...



Above: *Michael Granger installs the computer he designed especially for this project to maintain specific temperatures in the living areas of the solar house. The computer uses thermal information received from sensors located throughout the house to command the air-handling system 1275X2338–24A).* ***Left:*** *Mary J. McCauley, sister of the Granger brothers, prepares a meal in the spacious kitchen of the solar home. The recording device behind her monitors temperature and humidity inside the house to help determine efficiency of the prototype design and to aid in refining the design of future solar homes (1076X1282–19).*

maintenance, and repair cost. However, if one considers only the operating cost, the heating cost would only be about $7 per month for electricity to run the fan.

Helio-Thermics, Inc., builder of the house, is cooperating with ARS in the project. The Greenville, S.C., firm developed the solid-state electronic controller which operates the solar-attic

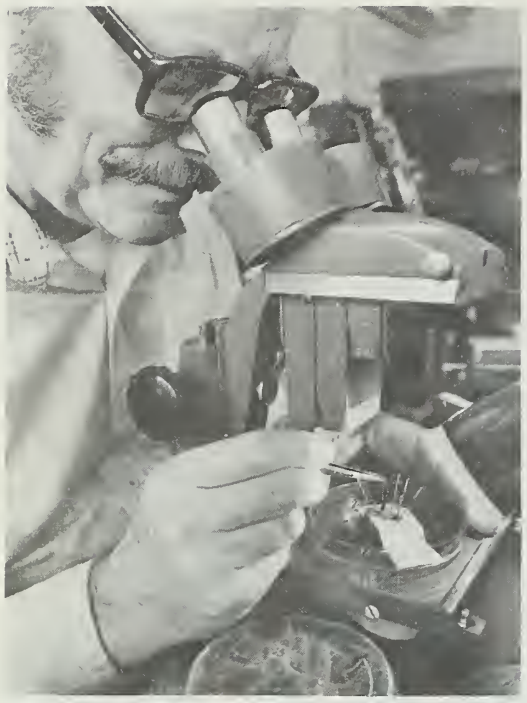
Right: *The air-distribution unit for the solar house is located where, in a conventional house, the furnace would be. Mr. Luther Godbey and Mr. Floyd Granger adjust settings before testing the solar heating system (1275X2339–16A).* ***Below:*** *ARS engineer Luther Godbey and Floyd Granger of Helio-Thermics, Inc., caulk potential air leaks between rafters in the heat-collecting attic. The north attic ceiling is insulated with 3½-inch fiberglass batt plus 1-inch rigid polystyrene that serves as an interior finish. The living area outer walls are insulated with 3½-inch fiberglass batt plus 1-inch polystyrene sheathing (1275X2340–21A).*

house's energy-conserving system.

Scientists at the Rural Housing Research Unit are currently working on plans that will reduce both the overall cost and the monthly operating cost. They are making a number of modifications in the air distribution system to eliminate the need for the very sophisticated control system. They also plan to use a smaller fan motor. These modifications may cut the total cost in half. If so, the cost of solar energy, including the cost of operation, maintenance, and repair, should not exceed $100 per year.

In addition to heating the home in winter, the system can also be used to cool the home in summer. This is done by blowing cool air through the rock storage tank at night and then across the night-cooled rocks during the day. A small air-conditioner will be installed in the system to aid in cooling and to reduce the humidity to a comfortable level. Moreover, increased air movement by convection up in the solar attic helps maintain cooler attic temperatures during summer than in a conventional home.

Construction plans are being prepared and should be available soon. Although the short test period and limited data collected thus far are not sufficient to accurately predict the performance of the present system in every location, the exceptional performance of the prototype house in Greenville, S.C., seems to justify early publication of the construction plans. Obviously, overall efficiency will vary in different locations. However, since this is easily compensated for with the auxiliary heating and cooling systems, the basic prototype design should be practical in most locations without modification.—*V.R.B.*



Above: *Mr. Sharpe removes the gut from a* B.t. *"challenged" Japanese beetle larva. Infected larva gut is analyzed for degradation effects; the gut from larva successfully resisting infection will be tested for pH level, a critical factor in susceptibility (1276X1589–6A).*

Right: *Japanese beetle larva is handfed* Bacillus thuringiensis, *called "*B.t.*" for short, spores and crystals. The challenged larva will be returned to petri dishes filled with moist peat and fed pieces of fresh potato (1276X1585–30).*

Crystals and Beetles

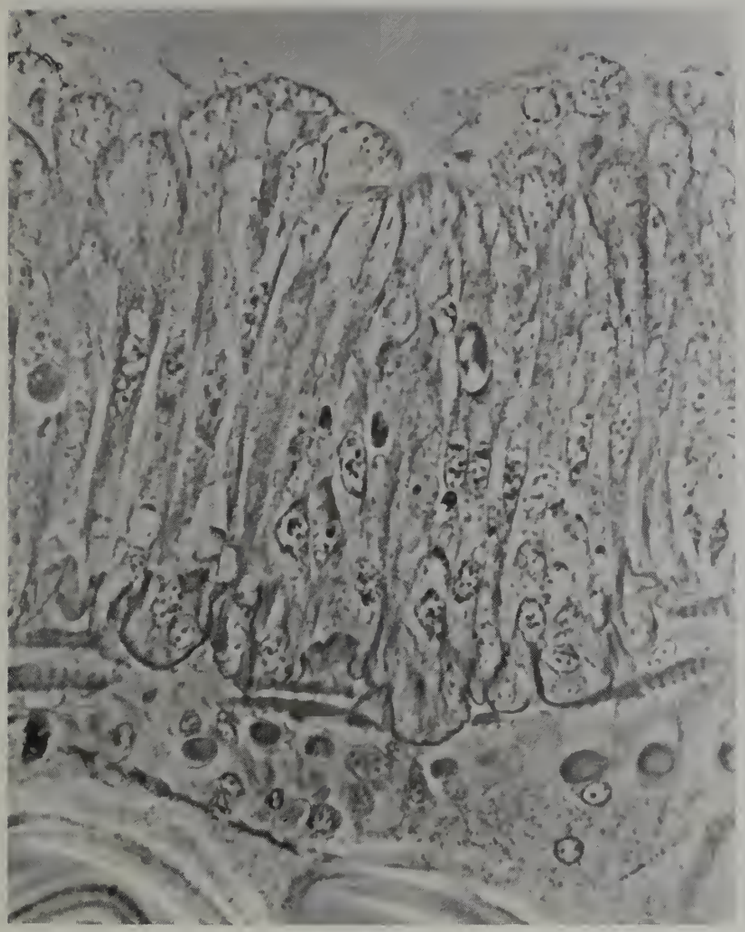
A BACTERIAL INSECTICIDE considered useful against only moth larvae contains an active ingredient that kills Japanese beetle larvae.

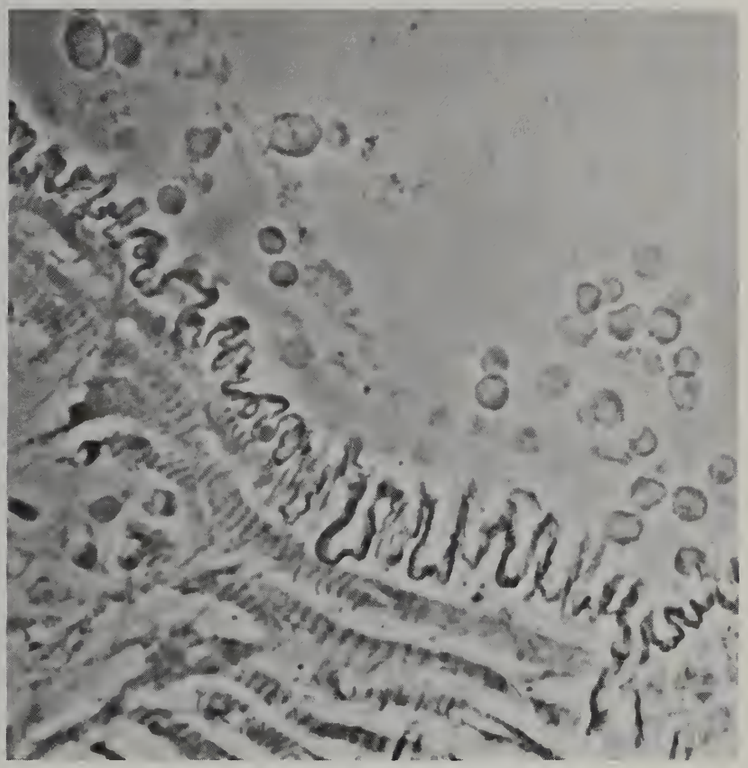
In laboratory studies, the ingredient, a crystalline toxin, killed Japanese beetle grubs (larvae) with highly alkaline (pH 9 or above) digestive juices that dissolved the crystals. The crystals are produced in the cells of *Bacillus thuringiensis* (*B.t.*), a bacterium, as the cells go into a dormant stage and form spores. Until now, scientists have attributed the pathogenic effects to toxins secreted by the cells—not to the crystals within the cells.

This first evidence that the *B.t.* crystals are toxic to a species of beetle was discovered by Eugene S. Sharpe, chemist at the Northern Regional Research Center (1815 North University St., Peoria, IL 61604). Preparations of *B.t.* spores and crystals are now sold as a specific control for moth larvae, such as corn borer and gypsy moth caterpillars. The discovery raises the possibility of using the crystals to control insects other than moths, especially Japanese beetles.

Mr. Sharpe says the crystalline toxin would have to be coated or encapsulated to protect it from soil microorganisms and to preserve its toxicity for actively feeding larvae.

"Microencapsulation should make the crystals a biological control agent for Japanese beetle larvae in their subterranean habitat," he says. The crys-





Above: *This microphotograph of a cross section of stomach wall, or gut, from a healthy Japanese beetle larva shows normally tall palisade (epithelial) cells (PN–4126).* ***Upper right:*** *Effectiveness of* B.t. *crystals is shown in this highly magnified cross section of damaged stomach wall. Twelve hours after the insect was infected, the* B.t. *crystals had destroyed the palisade cells that now float free revealing the wavy black line of the basement membrane. Destruction of the epithelial cells renders the stomach wall subject to invasion not only by* B.t. *but by micro-organisms native to the gut as well (PN–4127).*

tals or their toxic units might be combined in capsules with other insect disease organisms and with feeding attractants.

"*B.t.* crystals might be combined with spores and even vegetative cells of *Bacillus popilliae* to increase the virulence and efficiency of the milky disease bacteria in controlling Japanese beetles," Mr. Sharpe points out. There have been reports of increasing resistance to milky disease in Japanese beetles.

Mr. Sharpe and chemist Charles R. Russell are studying pine rosin and other crystal-encapsulating materials. Rosin dissolves in water at a pH of 9.2. Impregnated with the crystals, it should release the toxin only after it is swallowed by grubs with the highly alkaline digestive juices.

This level of alkalinity occurs only in actively feeding grubs and is more frequent in the spring, Mr. Sharpe believes. Sampling fall-collected grubs, he found a midgut pH range from 6.8 to 10.2. A pH of 9.5 has been the accepted value, without distinction between feeding and nonfeeding or spring and fall grubs, for more than 40 years.

The ARS scientist made the contradictory discovery in trying to account for another apparent contradiction: Moth larvae have a gut pH above 8.9 and are susceptible to the crystals; beetle grubs were supposed to have a gut pH of 9.5, but were not always susceptible in Mr. Sharpe's studies.

"The midguts of those grubs that survived the *B.t.* crystals did not contain food particles, and the gut contents were at pH 8 or below," Mr. Sharpe says. Midguts that contained food particles were at pH 9.5 or above.

"It appears," he concludes, "that the highly alkaline juices required for digestion are utilized within a few hours. If feeding is not continuous, midgut alkalinity drops to around pH 8. At this alkalinity, the grubs are not susceptible to the *B.t.* crystals."

In laboratory tests, *B.t.* crystals fed alone cause lesions in the grub gut. Micro-organisms native to the gut invade the blood-vascular system and cause "blood poisoning."

When grubs swallow *B.t.* spores with

the crystals, the spores invade the blood-circulating system along with the gut micro-organisms. Sometimes *B.t.* spores grow in the grub's blood in pure cultures.

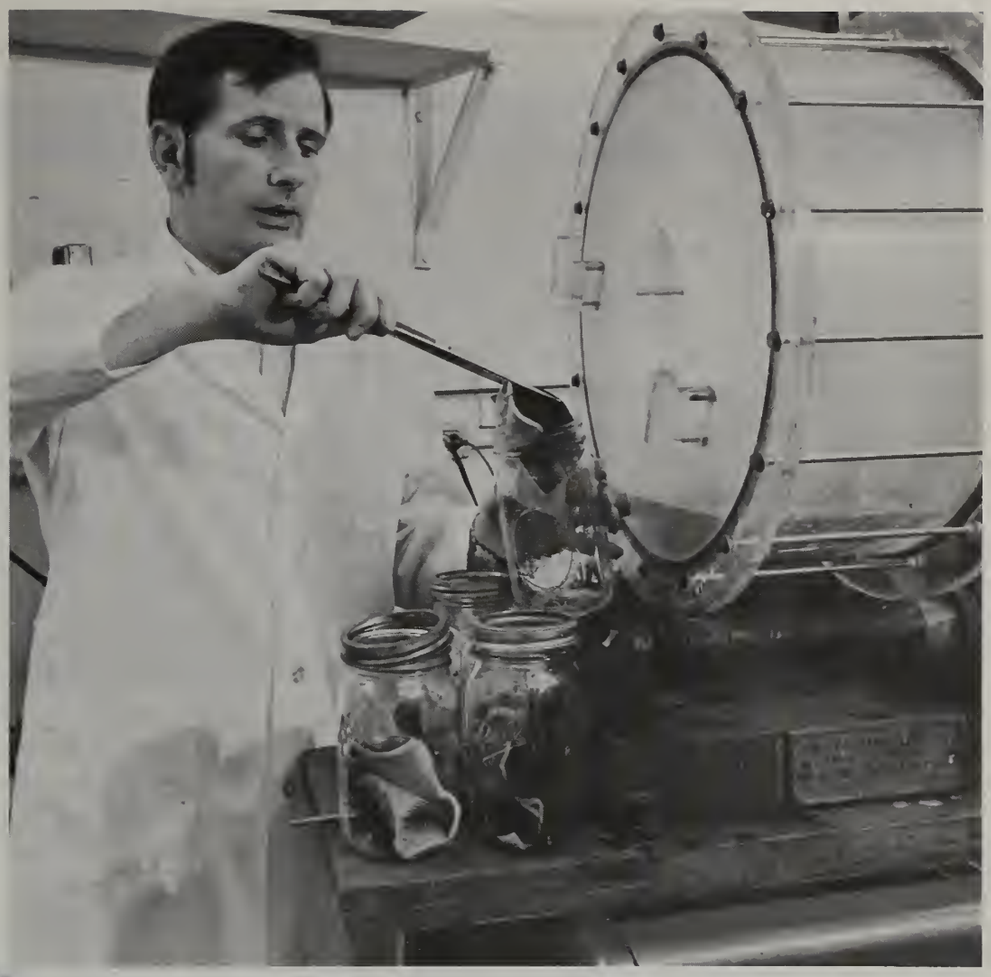
Since *B.t.* spores alone do not harm the beetle grubs, but they can invade the blood through crystal-induced lesions, *B. popilliae* cells might also penetrate lesions, making milky disease more virulent.

Milky disease spores obtained by artificially infecting captive grubs, an expensive operation, are sold now for Japanese beetle control. The vegetative, nondormant cells do not survive in the soil and are not used as an insecticide.

Japanese beetles and their grubs attack many species of grasses and ornamentals, garden and field crops, and trees and wild plants. From Canada to Alabama, beetle infestation is heavy east of Indiana, general in Indiana, scattered in Illinois and southern Michigan, and moving west. The beetles have been found at least twice near Kenosha, Wis., Chicago and East St. Louis, Ill., and Cedar Rapids, Iowa. There is a spot infestation near San Diego, Calif.—*D.H.M.*

Above: *As adults, Japanese beetles infest more than 275 kinds of trees, vegetables, flowers, and fruits. Beetles feeding on leaves chew the tissue between the veins, leaving a lacy skeleton; they often mass on ripening fruit, feeding until nothing edible is left (0874X1457–3A).* ***Below:*** *Japanese beetle larvae. The white grubs spend this life stage in the soil feeding on the roots of plants, particularly grasses. Often the damage they cause goes unnoticed until it is too late, when the plants have been permanently stunted, or die (0674R989–2).*

Hold the Salt



Dr. Bailey removes samples of fresh cowhide from a laboratory-scale treatment drum. The samples, which have been treated with sodium sulfite and acetic acid preservatives, are stored for selected time periods and then tested for microbial activity (1176X1479–17).

SALT that is used to prevent spoilage in fresh hides is one of the main pollutants in the leather-tanning industry—and the amount of saline pollutant from hides stored only a few days is as great as from hides stored several months.

In an experimental curing method developed by ARS scientists for short-term storage, no salt is used. Acetic acid and sodium sulfate replace salt. The amount of saline waste is reduced by about 97 percent.

The maximum time that hides can be stored if cured with the acid-sulfite treatment has not been definitely determined, but it has maintained hides in good condition for as long as 28 days. Using this as the assumed limit, the ARS scientists estimate that if all hides held less than 28 days were given the acid-sulfite treatment, the amount of salt pollutant in U.S. tannery effluents would be reduced by 75,000 tons annually. A side benefit is cost reduction. Savings of up to $50 million a year are estimated.

Chemists David G. Bailey, William J. Hopkins, and Edward M. Filachione developed the method at the Eastern Regional Research Center (600 East Mermaid Lane, Wyndmoor, PA 19118).

Locker operators and other slaughterers who produce only a small number of hides are the ones most concerned with short-term storage. They normally store hides for a few days until a truck from a central facility collects them.

The practicality of acid-sulfite preservation in this kind of business was demonstrated in a cooperative test by ARS, a commercial locker plant operator, and a hide dealer. Scientists at the Wyndmoor laboratory provided the acetic acid-sodium sulfite solution and directions for use. Locker plant personnel did the work, which consisted mainly of soaking hides in the solution for 10 minutes, then placing them in a barrel until they were collected.

The hides were marked, enabling the ARS scientists to track them through various processing steps, until they were made into leather. This leather had the same quality as leather from conventionally processed hides.

Other methods of nonsalt curing are under investigation. The objective is to give hide handlers and processors the opportunity to select a pollution-preventing method best suited to individual need.—*A.J.F.*

AGRISEARCH NOTES

Removing costly herbicides

TODAY'S HERBICIDES might be "herbicide$" in any spelling bee. A 50- to 70-percent reduction of spray material would be a windfall in weed control programs particularly for cotton and soybean farmers.

Recent innovations may make that possible.

A new technique of recovering the spray not deposited on vegetation is being evaluated for the control of weeds within the tentlike canopy made by the crops and to control weeds taller than the crop.

ARS agricultural engineer J. Ray Williford, Delta Branch Experiment Station (P.O. Box 225, Stoneville, MS 38776), and Mississippi Agricultural and Forestry Experiment Station plant physiologist William L. Barrentine have adapted a recirculating sprayer; it allows the herbicide to be spread horizontally across the row and through the crop and weeds.

The herbicide solution not deposited on the crop and weeds is collected in a trap on the opposite side of the row and returned to the spray tank. By adjusting the height of the spray nozzle, the herbicide can be directed across the row at a height that would give the best ratio of crop injury to weed control.

Sicklepod growing 3 to 8 inches in 8-inch soybeans was sprayed with five herbicides. The "payoff": 70 percent of the spray material was recovered. This method gives the same weed control as conventional methods.

For more efficient control of sicklepod after it reached a height of 10 to 12 inches, a weed roller-sprayer was also designed.

The unit consists of a pair of rollers 4 inches in diameter and 8 inches wide, positioned one each on each side of the row. The rollers are separated by 4 inches, and a shield beside each roller lifts the lower branches and directs the soybean plants between the rollers.

Sicklepod plants adjacent to the soybeans are rolled to the ground and sprayed with herbicide by a nozzle mounted behind the roller. This allows the entire weed to be sprayed, while protecting the crop.

The unit rolled 10- to 12-inch sicklepod plants down in soybeans without crop injury.

Extensive field testing of the new techniques is planned in 1977.—*P.L.G.*

Disrupting a courtship

BREAKING UP a romance is hard to do but when you are out to disrupt someone as prolific as the tobacco budworm, *Heliothis virescens,* it is nearly impossible.

Undaunted by this formidable pest of cotton, entomologist Donovan E. Hendricks, Cotton Insects Research Laboratory (P.O. Box 1033, Brownsville, TX 78520), studied the effects of components of the synthetic sex pheromone of the tobacco budworm on male response, female pheromone production, and overall disruption of courtship behavior. Mr. Hendricks reasoned that disrupting the courtship behavior of the males and their ability to locate "calling females" would check propagation of subsequent generations of tobacco budworms.

Female tobacco budworms by themselves or accompanied by formulated sex pheromone components were used as bait in traps in field cages. Pheromone components, Z-11-hexadecenal (Z-11-HDAL) and Z-9-tetradecenal (Z-9-TDAL), were combined in dispensers at a 32:1 ratio or applied separately at equivalent dosages.

The tests revealed that Z-9-TDAL had the greatest potential as a control agent because it disrupted male mating behavior and decreased trap catches at minute dosage in comparison to Z-11-HDAL used alone or in a mixture.

Atmospheric permeation and mating disruption with Z-9-TDAL over large areas in the field are the next steps in testing whether disruption of tobacco budworm romances will check the threat to cotton.—*E.L.*

Bees and beans

COULD SOYBEANS rival clover and wild flowers as a nectar source for honey bees? It is a two-way street, according to entomologist James J. Lackett.

The need for nectar has increased as land is cleared for improved pasture, housing, industry, logging, and highways, which decreased the bee forage plants previously available. Many fields containing palmetto and blackberries have been cleared for ryegrass—useless to honey bees.

"Beekeepers are not the only people interested in bees visiting soybeans," says Mr. Lackett. "The effect bees have on cross-pollination, increased yields of soybeans, and a hybrid soybean is important. When bees visit soybean blossoms, and when more than one soybean variety is present, the bees may transfer pollen from one variety to another. The result of this cross-pollination may, in some cases, be increased yield."

The biggest "if," then, lies in the possibility of desirable crosses. If a more productive hybrid soybean results, the beekeeper, the soybean-grower, and the consumer all profit.

In some parts of Missouri, Arkansas, Iowa, and Nebraska, beekeepers are producing substantial crops of honey from soybean fields. Others are complementing their honey production with nectar from soybean bloom.

But in other areas with certain "unattractive" varieties and under poor environmental conditions, bees will not visit soybeans. For example, in Arkansas soybean crops good for nectar may grow 1 mile away from fields of a different soil type, where soybeans produce no nectar.

Bee researchers can determine the quantity and quality of soybean nectar by extracting minute amounts of nectar from individual blossoms. A micropipette is inserted into the blossom and the nectar is allowed to rise in the pipette by capillary action.

A beekeeper, once aware of nectar that can increase the honey crop, will be able to determine if enough attractive soybeans are planted in the area.

If many plants are increasingly unavailable to bees, soybeans are not. In 1977, 54,732,000 acres of soybeans are expected to be planted in the United States.

Mr. Lackett, at the Bee Breeding and Stock Center Laboratory (Route 3, Box 82–B, Ben Hur Rd., Baton Rouge, LA 70808), cautions against generalizing about the value of soybean nectar. However, he does point out the increasing need to identify and evaluate soybean varieties as a valuable nectar source for the future.—*P.L.G.*

Ebony weevil

THE EBONY STRAIN of the boll weevil is as vigorous and has as low mortality as other strains, including those found in the natural environment.

The ebony strain is a mutant weevil that has been reared in the laboratory for many years. It has a black body color which makes it easy to distinguish from wild weevils, an important trait in research and eradication programs.

It was feared that the ebony strain might not have the vigor to compete with natural wild weevils in a sterile-release program, and that it might have a substantially higher mortality rate.

Tests, however, conducted by entomologist Roy E. McLaughlin, Boll Weevil Research Laboratory (P.O. Box 5367, Mississippi State, MS 39762), have shown that the ebony strain is equal to the five other strains tested for vigor and mortality. It is, therefore, suitable for sterile-release programs.

The low vigor and high mortality of the ebony weevil observed in some instances in the past were due to bacterially contaminated food. The bacteria damage the weevil's midgut and cause malnutrition and desiccation which, in turn, lead to loss of vigor and early death. This is a serious problem in mass rearing programs of sterile insects, which are released to compete with and reduce populations of insects in the natural environment. The ebony strain of boll weevils recovered from malnutrition and desiccation equally as well as the other strains.

Dr. McLaughlin emphasized the need for "utmost sanitation in all stages of the mass rearing program."—*B.D.C.*

Herbicides for cotton pests

A TEAM of scientists from ARS and Texas A. & M. University has discovered what could be a powerful new biological weapon to fight the bollworm and budworm, increasingly destructive pests of cotton.

Last year the American farmer lost $160 million to these pests which have also caused thousands of acres of land, previously used to grow cotton, to be diverted to other crops.

The team, including ARS chemist Robert D. Stipanovic, National Cotton Pathology Research Laboratory (College Station, TX 78840), plant pathologist Alois A. Bell, entomologist Maurice J. Lukefahr, and Texas A. & M. chemist Daniel H. O'Brien, has isolated a class of naturally occurring pesticides called "heliocides."

The three heliocides isolated from cotton plants reduce survival and growth rate of the insects, thus reducing the damaging insect populations. The reduced pest population requires fewer applications of chemical pesticides, allowing populations of beneficial insect parasites and predators of bollworms and budworms to increase, further reducing the population of pests.

ARS scientists have been working since 1967 to find biological resistance in cotton to bollworms and budworms. They examined cotton plants that had been collected from the wild or from small "dooryard plantings" from Mexico, Central America, and South America, as well as islands in the Caribbean and Pacific.

Over 1,200 different collections were tested, and the researchers found some resistance in 78 of them.

They then observed that resistant plants frequently had larger numbers of dark-colored oil pigment glands on their leaves and flower buds than susceptible plants.

Compounds related to gossypol, previously identified in cottonseeds, were isolated and found to be toxic to bollworms and budworms. Further studies indicated, however, that other compounds contributed to the plants' resistance. These compounds are the recently identified heliocides.

The heliocides are also toxic to the pink bollworm, a major pest of cotton in the Western States.

The scientists believe that breeding for high levels of these compounds would provide effective, inexpensive, and noncontaminating pest control for the bollworm and budworm as well as the pink bollworm.—*B.D.C.*

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Weevil word is out

PARASITES of the alfalfa weevil have been released in the United States since the first one was imported from Europe in 1957. Many States, particularly those in the Northeast, have virtually biocontrolled the weevil with these natural enemies.

But with the alfalfa weevil still destroying $80 million worth of the U.S. crop annually, distribution of alfalfa weevil parasites must be accelerated. Entomologists at the Beneficial Insects Research Laboratory (501 South Chapel St., Newark, DE 19711), are asking other researchers to help, by collecting parasites from colonized areas and re-releasing them where needed. Of primary concern is controlling the weevil in the Midwestern States. There is also a possibility of some control in Southern States.

Entomologists Richard J. Dysart and William Day of the Newark lab have produced a blueprint of wider distribution for the five most effective parasites present in North American alfalfa fields. It comes in the form of a report featuring the date and location of every release and known recovery of each parasite.

Although detail on Western State releases and recoveries is included, the distribution report focuses on pinpointing parasites in the East. Maps of the United States east of central Nebraska show county-by-county releases and recoveries of each parasite. Each parasite is also separately listed by exact location.

Copies of "Release and Recovery of Introduced Parasites of the Alfalfa Weevil," Production Report No. 167, can be obtained by writing the ARS Information Division, USDA, Hyattsville, Md. 20782.—*S.M.B.*

Trenching sludge may be safe

TRENCHING SEWAGE SLUDGE may be environmentally safe. In 4 years of sampling, chemist Lawrence J. Sikora (Room 101, Bldg. 007, BARC–W, Beltsville, MD 20705), and coworkers have found no significant contamination of ground water near experimental 2-foot deep trenches of digested and undigested sludge.

Digested sludge is the product of a sewage treatment process by which micro-organisms "digest" the organic solids of sewage sludge in air-tight tanks.

Dr. Sikora says that periodic testing of water from observation wells 50 yards from the experimental sludge trenches showed no prohibitive levels of nitrate, chlorides, or ammonium.

Only for a short period, occurring 20 months after trenching, did the sludge cause nitrate-nitrogen levels in observation wells directly beneath the trenches to peak slightly above Federal standards for safe drinking water (10 parts per million). The level fell rapidly thereafter, notes Dr. Sikora.

After 4 years of entrenchment, undigested sludge actually had a lower nitrogen level than did digested sludge. Both types of sludge had low levels of nitrogen—0.14 percent for undigested and 1.4 percent for digested—compared with 3 to 4 percent nitrogen levels before trenching.—*S.M.B.*

When reporting research involving pesticides, this magazine does not imply that pesticide uses discussed have been registered. Registration is necessary before recommendation. Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if not handled or applied properly. Use all pesticides selectively and carefully.

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